AD 678922

TRANSLATION NO. 1103

DATE: July 1968

DDC AVAILABILITY NOTICE

This document has been approved for public release and sale; its distribution is unlimited.

DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

12

#1103
9.1

Biology and Flights to Outer Space

Active Member of the Acad Med Sci USSR Prof N.N. Zhukov-Verezhnikov and Docent V.Ya. Kop'yev

Science & Life #9, 1962
pages 15-20

Manned flights to Mars and other adjacent planets unquestionably occupy first place among the more or less remote prospects of conquering cosmic space. A number of qualitatively new difficulties will arise, the greater part of which will relate not to the technical side of the matter but mainly to the unsolved biological problems. Of particular interest from the biological point of view will be the problem of extremely distant flights which will require speeds approaching that of light.

Biological conditions of flights to the nearest planets.

Long before the flight of Yu. A. Gagarin and G.S. Titov it was proven by means of special apparatus and various methods of investigation that flights around the Earth, measured in hours and days, transfer no only sufficiently stable biological objects -- bacteria as well as their spores -- but also such delicate systems, as isolated cells of the human body which grow in so-called monolayer cultures. During such flights the cells withstand vibrations to which they are subjected, accelerations, the state of weightlessness, and the effect of relatively small doses of ionizing radiation which takes place in cosmic space. It can be stated, although it still needs experimental verification, that these cells will withstand even more prolonged flights, for instnce to Mars and back. At any rate, upon transfer to the nearest planets, there will hardly be any danger of the death of these cells. This fact has been attested by experiments carried out on spaceships. Cells, brought back from these flights, virtually suffer no physiological changes as compared with those left on Earth.

The same can be said in regard to genetic problems. It has been demonstrated that the stay in cosmic space of genetically very sensitive biological objects -- the so-called lysogenic bacteria -- causes no hereditary mutations in them. It should be pointed out that lysogenic bacteria, lysogenic intestinal bacilli in particular, represent cells which externally do not differ from regular cells. However, among

other inherited characteristics they carry the hidden property of producing bacteriophages.

Phages are the minutest creatures which for a long time were thought to be only parasites of bacteria, which attach themselves to the latter from without. However, the conviction gradually grew that these are not simply parasites; they are so closely connected with the bacterial cell that they are capable, on the one hand, of affecting its biology and, on the other, they themselves are fully dependent on the physiology of the bacterial cells. In contrast to other living creatures, bacteriophages do not proliferate via mitosis, but seem to be produced by the bacterial cell. The cell produces separately nucleic acids of which the bacteriophage nucleus is comprised, and "manufactures" separately the protein of which subsequently the phage protoplasm is built. Both are combined into a single supermicroscopic organism only after the completion of the biosynthesis of the molecules which comprise these substances. Hence, the bacterial property of producing bacteriophages represents a genetic reaction and is closely connected with their herditary mutation.

This mutation takes place mainly under the effect of radiations, cosmic radiation in particular. In contrast to other living organisms, in whom heredity changes take place only under the radiation effect of 100 r or more, the heredity and the associated property of B. coli of producing bacteriophages is affected by as little as mere fractions of Roentgen. Thus, they represent a biological object which possesses the greatest sensitivity in regard to ionizing radiation, including cosmic rays.

Being in possession of such a model and having considerable experience of utilizing it in cosmic space, it is not difficult to determine, whether there is any genetic danger present on such routes as Earth -- Moon -- Earth, or Earth -- Mars -- Earth, before man will fly these routes. If it will be found that such danger exists, effective methods of protection against genetic effects of cosmic radiation and other factors of cosmic flights will be developed (corresponding measures are being worked out at present).

However there is another and more complicated problem connected with flights to the nearest planets.

Planet microorganisms and the prevention of their penetration to the Earth

Up to recently the specialists gave little thought to the forms of life which man may encounter on other planets. Now, however, this question became so important that it merits attention.

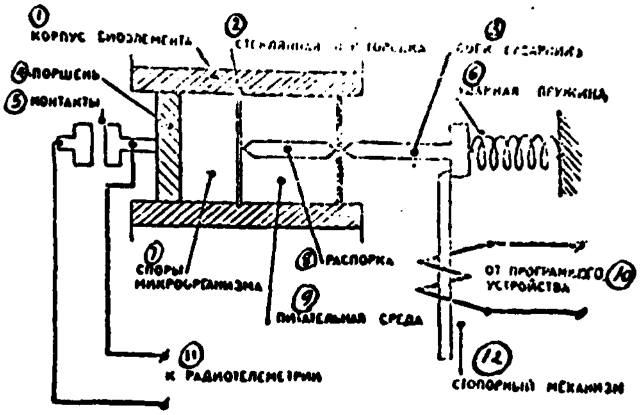

Fig. A

Design of the Acad Med Sci bioelement with a glass partition between the chambers in which bacterial spores and the nutritive medium are contained.

1 Bioelement body
2 Glass partition
3 Striking pin
4 Valve
5 Contacts
6 Striking spring
7 Spores of the microorganism
8 Cross bar
9 Nutritive medium
10 From the program device
11 to radiotelemetry
12 locking device

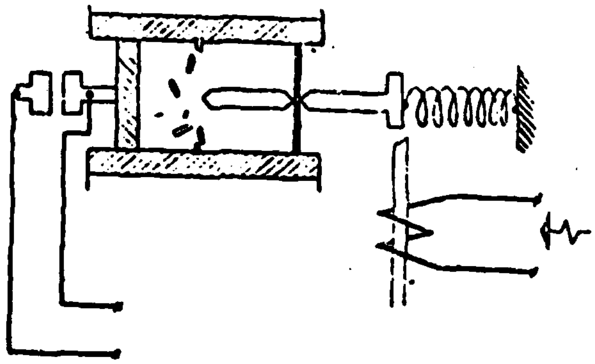

Fig.B

Upon signal from Earth, the striking pin breaks the glass partition. Thus, the "seeding" of spores is accomplished.

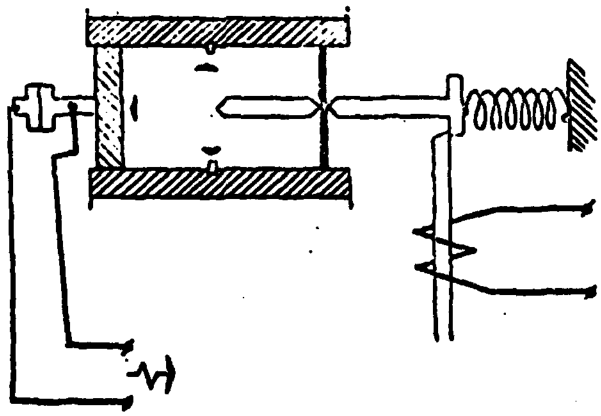

Fig C

The pressure of gases, released during the growth of bacteria, pushes aside the valve and locks the contects of the signal device.

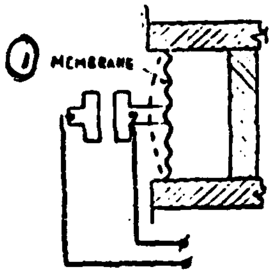

Fig D

Variant of the bioelement device. Here, the valve is replaced by a flexible membrane.

(1) Membrane

There is a great deal being written of the necessity of preventing the carrying of terrestrial microorganisms to other planets. At first glance it seems that one should not worry too much about it, since life conditions on other planets differ from our, and the terrestrial microbes may not survive there. However, according to Academician A.A. Imshenetskiy, the range of adaptive properties of microorganisms is very great, and no assurance can be given that terrestrial microbes would not find a suitable soil for their proliferation on our neighboring planets.

This premise should be extended also in regard to the microorganisms (if such exist) which live on other planets. Indeed, will not our spaceships returning from the Moon and Mars to the Earth bring over some microorganisms which may prove dangerous to man, animals, and plans? There is of course a possibility that some of them might prove beneficial to the terrestrial world. At any rate, it seems to us that the possibility of carrying microorganisms from "alien planets" to the Earth should more attract more attention of biologists than the possibility of populating other planets with terrestrial microbes. No theoretical considerations can offer a guarantee that the entry of microorganisms to the Earth is impossible or that they will prove to be harmless.

It is considered in principle that microbial parasitism which is connected with the property of microorganisms to induce diseases is the result of a complicated and prolonged biological adaptation of the parasites to the host's organism on which they parasitize. We know that we are surrounded by miriads of harmless microorganisms and that the parasites generally comprise a small part of the biosphere -- the surrounding ocean of life consisting mainly of microorganisms. Parasitic microorganisms, unquestionably, possess special adaptative properties which have been developed in the course of a long evolutional period. They penetrate the organism by overcoming the protective actions of the animal or planet, and they are also capable of being excreted from the organism and find a new medium of habitation, a new victim. In the light of these theories, it would seem that planetary microorganisms, if they exist, would not be able to cause any harm to man. However, one connot depend on theoretical premises alone or on experiments carried out under terrestrial conditions. We know of instances where microorganisms, which had never encountered a given species of animals or plants, turn out to be capable of producing infectious diseases or, at least, intoxications with microbial poisons.

In this connection, it is of particular interest that specialization, i.e., a narrow adaptation of microorganisms

to a certain species of animals undergoes fairly large fluctuations, depending on the microbial species. Thus, for example, the typhus fever microorganism afflicts only two biological species -- man and the louse which is able to parasitize on man. On the other hand, the tularemia microorganism is capable of afflicting an immense number of animal species, especially rodents. The same can be said in regard to anthrax.

There are also microorganism which excrete particularly strong toxins. For instance, botulism toxin excbeted by Cl. botulinum kills large animals even in microscopically minute doses, if it penetrates the organism with food or inhaled with air. Thus, no biologist can give us a guarantee at present that microorganisms of "alien planets" will prove absolutely harmless.

What measures can, then, be taken to protect the Earth from the entry of such undesirable forms of planetary microorganisms? For this purpose, it is necessary in the first place to investigate the surface of the Moon or Mars so as to ascertain whether there are microorganisms and what is their nature. How is this to be done?

It is very risky to postpone this ivestigation until the time when man will first land on the planet. The first thing the cosmonaut will encounter, if there be any forms of life, will be microorganisms and, of course, he will be unable to examine them before return to Earth. Thus, there will arise the danger of carrying undesirable microorganisms to our planet.

It would, therefore, be rational to attempt first an investigation of the surface of planets by means of automatic biological devices.

The second Soviet spaceship contained the so-called bioelements of the Acad Med Sci -- devices capable of recording automatically the proliferation of microorganisms enclosed in these devices and transmitting corresponding signals to the Earth. The AMS bioelement represents a container (usually a metallic cylinder), divided by a glass partition into two chambers. One of them contains the spores of microorganisms of butyric acid fermentation, the other contains a nutritive medium. An automatic mechanism, at a signal from the Earth or from the program device on rocket-board, breaks the glass partition. Thus, is the "seeding" of microbial spores on the nutritive medium accomplished. The proliferation of microorganisms is accompanied by the formation of gases. The increased pressure acts on the corresponding transmitter and, through it, on the radiotelemetric apparatus which sends a signal to the Earth, The microorganisms almost literally press the button to inform us that they are alive and well.

The successful utilization of these devices in outer space is the first step toward the development of apparatus which could carry out an initial investigation of the planetary surface and ascertain the presence or absence of microorganisms at the landing sites of spaceships.

The development of problems connected with these efforts represents is very complicated, but an exceptionally fascinating task. It is necessary to compose nutritive media which would prove suitable for the proliferation of unknown microorganisms, about which we don't even know whether they consist of the same protein substances as their kin on Earth. However, a considerable part of these difficulties has been theoretically overcome, and similar further tests can be assured not only from the technical, but also biological point of view.

In addition to direct results -- familiarization with forms of life beyond the Earth -- cosmic investigations also offer exceptionally valuable indirect results. The experimental works, required to make a path for man in space, will create new methods of investigation and reveal new facts which, unquestionably, will contribute to the progress of the purely terrestrial investigations.

In coming back to the problem of protecting the Earth from infection from outer space, we may state that biological science is able of ensuring the safety of the cosmonauts themselves, as well as the people of the Earth who will impatiently await their return. In addition to a preliminary microbiological investigation of the planets and, independently of that, all rockets returning from space flights will of course be disinfected with particular thoroughness, and the cosmonauts kept under certain quarantine.

All above-stated does not of course exhaust all the problems of biological investigation connected with the first flights to the planets. However, the discussed problems, together with the solution of purely medical tasks connected with the provision of nutrition and respiratory requirements of the cosmonauts, are the most important ones.

Modern biological investigations connected with the travels of man to the planets are not only possible, but are to a considerable extent actually ensured with proper methods and apparatus.

It is a different matter in regard to biologically ensuring distant space travel where the speed approaches that of light.

Biological conditions for distant space flights at speeds approaching that of light

It seemed very recently that distant space flights at speeds approaching that of light is a matter of such distant future that the biologist did not have to hurry with a discussion of the associated problems. However, the development of cosmonautics has been advancing so rapidly, and the problems in the field of biological ensurance of distant flights are so complex that the biologist may be late, unless he starts right now with the discussion of the corresponding problems.

In order that space apparatus achieved speeds comparable to those of light, more than technical improvements will be needed. The biological problems will most likely be of paramount importance. They are mainly connected with the fact that, upon drastic increase in speed, certain physical phenomena not encountered under usual velocities will come to the fore. The period of rocket acceleration, i.e., the time from the start and up to the achievement of a steady uniformly-accelerated motion, will unquestionably take up a long time and, thus, the living objects will be subjected for an extended period of time to the force of acceleration. True, it will take place beyond the terrestrial field of gravity.

Apparently, the possibility is not excluded that, upon passing a certain velocity threshold, the effect may be felt of the increase of the mass of atoms which comprise the giant molecules of living cells. How will this be reflected on the metabolic processes carried out by such molecules? Will the molecules as a whole be subjected to uniformly-accelerated motion, or will some conditions originate which would contribute to their separation into atoms in connection with the effect of unusual velocities. In other words, a unique biological problem arises which can formulate as follows: is life possible when the organism is under the effect of increased accelerations, as well as velocities approaching those of light?

Perhaps the physicists will tell us that this factor will have no effect on the structure of live molecules and on the interaction of atoms within them, and that the question, thus, does no longer arise. It seems to us, however, that special proof is needed in this case.

Naturally, the question arises whether this problem could not be solved experimentally. The biological part of such experiment can be arranged at the present time. If it were possible today to accelerate rockets to near-light velocities and obtain radio signals from such rockets on the Earth, we could employ for the solution of this problem the AIS bioelements or other type and structures of bioelements.

During the acceleration period, the microorganisms will

be present in the bioelement in the form of spores; spores are very stable, tolerate any stress which can be created on Earth, withstand boiling, freezing, and radiation effects of scores of thousands of Roentgens. It can be expected that the spores will pass successfully through the acceleration period and, at a corresponding moment, can be seeded on a nutritive medium.

The bioelements are of the size of small "finger-shaped" radiolamps, and can be placed by the hundreds on rockets. They can be cut-in one after the other also during the acceleration, in order to ascertain at what moment of the increase of accelerations forces enter into action which are dangerous to living organisms. Thus, the entire segment of the flight can be investigated from the start to the end of the acceleration period, and precise data obtained concerning the possibility of the existence of living organisms at various velocities, including those where so-called relativist effects come into operation.

In the flights of rockets and spaceships, flying at velocities approaching those of light, of no less interest is the problem of the relative increase of the energy of cosmic particles during their possible collision with the flying apparatus, and their effect on the biological objects. We have in mind the so-called "primary" and "secondary" cosmic rays. [It is assumed that "primary" cosmic rays represent nuclear fragments of a large number of particles -- from protons to heavy elements -- while "secondary" cosmic rays are the result of the collision of heavy high-energy "primary" particles with the particles of the atmospheric medium].

Upon flight velocity of 160,000 km/sec, the radiation dose level, following bombardment of the ship with protons and electrons, will be colossal. It is thought, however, that this threat can be removed by proper screening.

The possibility of biological verification of the relativity theory

We know the premise of Einstein's theory in regard to the fact that to an observer moving at a velocity comparable to that of light the time flows more slowly than to the motionless observer. This is the so-called time paradox. Experiments with elemental particles proved its mathematical correctness.

However, what will happen to a live organism which will fly in an interstellar ship at a velocity to that of light?

How will its biological processes run? The authors of science fiction novels assert that they will take place at a retarded tempo -- retarded to the same extent as the flow of time. Their heroes return from distant cosmic flights as "coevals" to their grandchildren.

Are the writers of science fiction correct?

Perhaps, in order to answer this question, it is necessary to await the time when man will undertake the trip to the stars in a ship flying at a speed of light.

It seems to us that even prior to human flight it will be possible to verify experimentally the correctness of the time paradox for living creatures. Will the bioelements be helpful in this case? Microorganisms with their very short life-span are the most suitable object for such an experiment.

Indeed, a dog, for instance, lives 10 to 12 years. In order to verify on the dog the correctness of the time paradox, we would need two puppies of the same litter -- coevals -- leave one on the Earth and send the other puppy into space on a rocket flying at velocity approaching that of light. Upon return of the quadruped-"cosmonaut," we would have to compare its age with that of its "terrestrial" brother. However, the difference in age, measured by a few days or even weeks, is scarcely perceptible. If the difference is to be sufficiently perceptible to the experimenters, the flight of the experimental dog must last a very long time.

It is a different matter as far as the microorganisms are concerned.

By means of a bioelement it is possible to determine the time difference of the proliferation of microorganisms on Earth and in the rocket. It is only necessary to carry out the seeding of spores on a nutritive medium in two bioelements -- the control "terrestrial" and in the "cosmic" bioelement in the rocket.

If we proceed on the assumption that the proliferation cycle of microorganisms in a closed space will take place within 24 hours, the rocket with bioelements, according to our calculations, must reach the velocity of about 160,000 kilometers per second. The difference in the rate of proliferation in a cosmic flight and on Earth on the basis of the time paradox will comprise 14 percent. It can be measured according to the difference in the operation (under the effect of the pressure of gases formed during the bacterial growth) of the "terrestrial" and "cosmic" bioelements.

The discovery by the Soviet Union of a path into the outer space has led to a number of expected as well as unexpected results. These are, for instance, the qualitative changes in the character of the scientific investigations themselves. Science is approaching the boundary when the most complex and difficult tasks of space and study are being realized, where flights are impossible unless the highest level is reached of the development of specialties which serve those flights. This is essentially a unique test of the possibilities of science in general. Modern Soviet science has passed this test.

2007
CSO: 1873-N

END